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ABSTRACT

Forty-four education and 44 dental students were administered a 30-item syllogism test containing five syllogic forms six times repeated in three different content forms--technical dental terms, common dental terms, and content-free (letters). Data were analyzed using a two-factor with repeated measures on one factor design. It was found that dental students did not score differently than education students. However, content-free syllogisms were significantly less difficult to solve than technical or common content syllogisms. There were no interaction effects between subject group and content type. (Author)

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Familiarity with Content and Syllogistic Reasoning

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FAMILIARITY WITH CONTENT AND SYLLOGISTIC REASONING

It has been reported that as the meaningfulness of terms in a reasoning problem decreases, the difficulty of applying reasoning principles increases (Sells, 1936; Wason & Shapiro, 1971; Wilkins, 1928). Furthermore, it has been suggested that task characteristics such as inclusion of a memory aid can significantly affect ability to make transitive judgments (Roodin, & Gruen, 1970). Therefore, it might be supposed that content and task demands have impact upon a subject's capability to apply a principle of reasoning.

Content has been demonstrated to have impact upon the ease with which one solves syllogistic problems. For example, Roberge and Paulus (1971) have demonstrated a significant effect of three different content types in children's reasoning. With adult subjects, Roberge (1971a) has demonstrated that negating arguments in the major premise make syllogistic reasoning more difficult. In addition, Lippman (1972) has demonstrated that passive and negative syllogisms were rated by subjects as more difficult to solve than active or affirmative syllogisms.

The present research effort represents a further investigation of the relationship between reasoning and comprehension of the terms comprising the premises in syllogisms. In a general sense, the present study was concerned with whether application of syllogistic principles was impeded by the absurdity or abstruseness of the terms. Absurd premises were those which subjects knew not to be true in fact.

Abstruse premises were neither true nor false in fact, having no concrete referents. Bart (1972) has reported the pattern of development for absurd premises was not significantly different from abstruse premises for adolescent subjects.

The present study was designed to test the hypothesis that syllogistic principles containing abstruse terms would be no more difficult to apply than those containing absurd terms with adult subjects. In addition, it was hypothesized that performance with premises containing terms which were familiar to a subset of the subjects would be most like the performance with the absurd premises for that group of subjects, and most like the performance with the abstruse for the remainder of the subjects.

METHOD

Subjects

Subjects were 96 students at the University of Kentucky. Fifty-three of the subjects were completing the second semester of dental achool while the remaining 43 were graduate students in the College of Education. Forty-eight of the dental students and 15 of the education students were males.

Materials

A 30 item conditional reasoning test was constructed using the format of the Cornell Conditional Reasoning Test (Ennis & Paulus, 1965). Each item conformed to the following format:

Suppose you know that

Premise 1

Premise 2

Then would this be true?

Conclusion.

Subjects responded on an optical scan answer sheet according to the following code:

A. Yes - it must be true

B. No - it can't be true

C. Maybe - it may be true or it may not be true. You weren't told enough to be certain whether it is "YES" or "NO".

Five basic principles of reasoning were tested. These principles were: (1) modus ponens (P Q, P Q); (2) affirmation of the consequent or conversion (P Q, Q P); (3) denial of the antecedent or inversion (P Q, P Q); (4) modus tollens or contraposition (P Q, Q P); (5) transivity (P Q, Q R, P R). The discrimination indices for these principles were reported to be .06, .72, .72, .17, .10 by Roberge (1971b) using graduate students as subjects.

Each of the five basic principles was represented six times in a 30 item instrument in which items were developed in three forms. In the symbolic form, premises and conclusions were made up of symbolic terms using the letters A, B, and C, and P, Q, and R. The second ten forms involved the use of professional dental terms such as parulis, exanthematous viral disease, caries, gingiva, herpetic lesion, and lymphadenopathy. The lay dental terms corresponding to the technical terms comprised the content of the third group of premises (i.e., gumboil, chicken pox, tooth decay, canker sore, and swelling). It was reasoned that the symbolic content would be abstruse to both dental and education subjects, and the lay dental terms would comprise absurd premises to both groups of subjects. However, the technical dental vocabulary would result in premises being abstruse for education subjects but absurd for the dental students.

Informal group response showed that less than 10% of the education subjects were familiar with even the most common (i.e.,"caries") of the professional dental terms. The dental students were familiar with at least four of the six professional dental terms.

Procedure

The instrument was administered to education and dentistry subjects during regularly scheduled class sessions. No time limit was imposed but all subjects completed the 30 items in less than 25 minutes.

Instructions to the subjects were written. They contained four sample items, which were read aloud to the class by the instructor with the appropriate responses emphasized. Questions were solicited from the subjects to insure the instructions were understood. Furthermore, subjects were cautioned to respond only to the logic of the agreement assuming the premises were true even if they knew otherwise from their experience.

The data collected in this study conform to a two-way analysis of variance design with repeated measures on one factor. The two independent variables are student type (education vs. dentistry) and syllogism content (lay vs. professional vs. symbolic). Since a subject responds to all three

types of syllogism content there are repeated measures on the content factor. The design is also multivariate since there are five different syllogisms included in the study. The data were analyzed using a doubly multivariate analysis of variance model. In addition to the five syllogisms as multiple dependent variables, the scores of each subject on the three different types of content are included in the analysis. Contrasts used to transform the responses of individual subjects to those representing the content factor in the ANOVA design were:

	Lay	Professional	Symbolic
Mean	1/3	1/3	1/3
Lay-Professional vs. symbolic	1/2	1/2	-1
Lay vs. Professional	1	-1	0

The approach taken was that of Finn (1969). The analysis was performed using a computer program developed by Finn (1968).

RESULTS

The results of the multivariate tests of mean vectors are depicted in Table 1. As seen in Table 1, there was no overall difference in performance for the two types of students, education vs. dentistry. However, there was a significant difference found among the three types of content. Contrary to what had been hypothesized, there was no significant interaction between content and student type.

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insert Table 1 about here
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Univariate orthogonal contrasts were estimated for the content variable and hypothesis tests performed. The results for the content contrasts are depicted in Table 2. It can be seen from uniform significance of the univariate F values

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for the student means, and the significant step-down F for only the first mean, that performance on the first syllogism is similar to that on the other syllogisms—all seem to involve basically the same trait. In contrasting lay and professional with symbolic content, significant univariate F's were found in affirmation of the consequent, denial of the antecedent, and transivity. However, only transivity contributed to the step-down F suggesting that the first contrast performed, modus ponens, accounted for most of the variance in the grand mean. The Lay vs Professional contrast did not produce significant univariate F or step-down F values suggesting an absence of significant difference in performance on these two types of content across the five reasoning principles. Estimated contrasts are shown in Table 3. The results demonstrated that dental students and education students did not significantly differ in performance on

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insert Table 3 about here
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the reasoning test. However, there were significant differ-

ences in subjects' performance on the three different types of content. Orthogonal contrasts revealed significant differences in performance on three of five syllogistic forms between Lay and Professional content versus symbolic with symbolic leading to higher performance as indicated in Table 4. However, there were no significant univariate F ratios

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at the .05 level for the Lay vs. Professional contrasts suggesting that both kinds of content were handled about as well by subjects. Furthermore, the hypothesis that the technical content would produce arguments which were absurd to dental students, but abstruse to education students was not supported. Performance on items with technical content tended to be like performance on lay content in both groups.

DISCUSSION

The results primarily suggest two conclusions. The first is that the nature of the content influenced performance on some of the dependent variables. That all dependent variables were not affected similarly is of some interest. One might suspect that the difficulty associated with the syllogistic form might interact with content to produce the differential impact of content in premises. However, the discrimination indices reported by Roberge (1971b) do not support this, nor do the findings of the present study. The relationship of item difficulty to premise content seems an appropriate area for further research.

The second implication of the present study is that the abstruse-absurd dichotomy may not be a meaningful one for reasoning research. While present results offer some support the Bart (1972) findings of similar patterns of development for absurd and abstruse premises, the similar treatment of lay and technical content by education and dental students suggested that these content premises were treated in a common way regardless of whether the subjects were familiar with the terms. Since the symbolic content created syllogisms which looked very different from the other two kinds of content, that is they were shorter and more succinct, perhaps the length of the premises in a syllogism contribute to the difficulty one experiences in comprehending syllogistic forms. Furthermore, the distinction between application and understanding made by Smedlund (1970) may help to explain these results. That is, perhaps the subjects' understanding of the reasoning principles involved was demonstrated by the higher scores with symbolic content. However, application of the reasoning principles was impeded by the lay and professional content forms. More precisely, perhaps the professional content similarly influenced performance but for different reasons. For example, the lack of difference in performance of the two groups of subjects on professional content may have a more complex explanation. That is, while the dental students may have found the absurd content impeded their application of the reasoning principles, the education students may have found the technical vocabulary

distracting to the point of making application of the reasoning principles more difficult. Clearly, more research should be attempted to explore the effects of different types of abstruse and abstract content on reasoning before more definite conclusions may be drawn.

Table 1

Summary of Multivariate Analysis of variance

Source	Multivariate F	d.f.	p
Between Subjects			
Grand Mean	1191.616	5,90	.0001
Student Type	1.621	5,90	.1626
Within Subjects			
Content	2.528	10,80	.0107
Student X content	.671	10,80	.7480

TABLE 2

Orthogonal Contrasts among means for the significant content main effects.

Syllogistic Form	Contrast[a]											
	Grand Mean					Lay and Professional vs. Symbolic				Lay vs. Professional			
	Univariate			Step-Down		Univariate			Step-Down	Univariate			Step-Down
	MS	F	p	F	p	MS	F	p	F p	MS	F	p	F p
. Modus ponens	359.01	6029.42	.001	6029.406	.001	.058	2 664	.106	.001 .978	.003	.089	.766	.112 .739
. Affirmation of the consequent	170.63	283.31	.001	1.590	.211	1.044	11.925	.001	.187 .667	.260	3.164	.079	1.399 .241
. Denial of the antecedent	140.14	205.68	.001	.933	.337	.669	12.615	.001	.064 .801	.042	.494	.484	.252 .617
. Modus tollens	167.97	375.52	.001	.003	.960	.669	3.557	.063	.839 .362	.042	.414	.522	2.882 .094
. Transivity	292.77	1237.98	.001	.366	.547	.298	4.974	.029	15.012 .001	.260	3.392	.069	3.536 .064

a. Error degrees of freedom were 94.
b. Mean responses for each subject also removed.

TABLE 3

Estimated Contrasts and Standard Errors (S.E.)

the Content Contrast of Interest

Syllogistic Form	Lay + Professional − 2 × Symbolic		Lay − Professional	
	Contrast	S. E.	Contrast	S. E.
1	-.023	(.015)	.006	(.018)
(mean removed)	-.002	(.121)	-.075	(.141)
2	-.107	(.030)	-.053	(.029)
(mean removed)	-.111	(.250)	-.393	(.241)
3	-.087	(.024)	.019	(.030)
(mean removed)	-.063	(.200)	.031	(.241)
4	-.080	(.044)	.021	(.033)
(mean removed)	-.333	(.367)	.350	(.251)
5	-.059	(.025)	-.050	(.028)
(mean removed)	-.747	(.185)	-.023	(.237)

TABLE 4

Means and standard deviations of subjects' performance on five syllogisms with lay dental (L), professional dental (P), and symbolic (S)

Syllogistic Form	Subject Group					
	Education			Dental		
	L	P	S	L	P	S
1. Modus Ponens						
$\bar{X}$	1.94	1.94	2.00	1.90	1.88	1.91
s.d.	.23	.23	0.0	.36	.39	.43
2. Affirmation of the consequent						
$\bar{X}$	1.23	1.32	1.40	1.23	1.35	1.49
s.d.	.87	.83	.84	.84	.87	.77
3. Denial of the antecedent						
$\bar{X}$	1.26	1.19	1.30	1.09	1.09	1.28
s.d.	.90	.88	.85	.89	.84	.88
4. Modus tollens						
$\bar{X}$	1.20	1.17	1.36	1.42	1.37	1.47
s.d.	.82	.83	.70	.70	.76	.77
5. Transivity						
$\bar{X}$	1.74	1.87	1.85	1.58	1.65	1.74
s.d.	.56	.44	.41	.70	.69	.58
GRAND MEANS	1.47	1.50	1.58	1.44	1.47	1.63

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